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ABSTRACT

Current and approaching crises in man's inhabitation of the Earth are discussed and enumerated. Education is proposed as a method of alleviating the social, ecological, psychological, and eventual biological pressures created by man's increasing subjugation to technology. The emerging pattern of disaster for man as a species is delineated, and a humanistic and philosophical approach to education is suggested as the only effective means by which to develop individuals capable of making the types of decisions that man's monumental technology has put him in the position of having to make. An extensive bibliography is appended. (LH)

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TOPIC: Energy and Technology: The Emergence of a New Agenda for Professional Association Leadership

TITLE:

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Appropriate Technology and Education

Our people have always placed great faith in education. The hope today is that somehow what the public schools and colleges are doing will prepare the next generation to transition successfully to the 21st century and meet the critical challenges of survival in a world of increasing population, finite resources, deteriorating environment, rising expectations and technical systems seemingly out of control.

To many the challenge to educate ourselves and prepare for the future has never been so great. Where people once considered the present to be stable, they find their lives being altered on an almost daily basis by forces beyond their control. With the advent of more powerful and disruptive forms of technology, used by more and more people worldwide, quantitative changes of great magnitude have occurred. We have experienced exponential growth in all forms--machines, highways, automobiles, new forms of communication, energy use, specialized knowledge and perhaps most significantly, higher and higher levels of destructive power in the form of nuclear weapons. The latter has brought about what Arthur Koestler classifies as the most significant qualitative change in the history of civilization. Prior to the advent of nuclear power people lived with the idea that death was an individual occurrence. With the advent of nuclear weapons humans have had to live with the possibility of death as a species (Koestler, p. 322, The Ghost in the Machine).

Even without nuclear and thermonuclear weapons, the power for altering life on earth through the destruction of the ecosystem, either by use of powerful machines or powerful new chemicals, reached a point by the latter part of the 20th century that significantly altered commonly held perceptions that the future would be better based on the idea of a progressive evolution through technology. The age of innocence ended with the stark realization that a powerful disruptive technology controlled by the ignorant or socially insensitive could create not only untenable futures for humankind but could also destroy civilization as commonly known.

We are entering a new world, and we are not very well prepared for it. The basic questions of all time are still in need of answers. Who are we? Why are we here? Where are we going? How are we going to get there? These are questions that are seldom entertained in public education today, seldom raised in public forums. After all, we know the answers. Or do we? Notice the focus of the questions. The focus is on human beings, on individuals. They are questions that have to do with emancipation, with liberation, with freedom, with being human.

I submit to you that the answers to these questions have been and are being altered greatly by a little understood but very human endeavor, namely, technology; and that if we desire to liberate ourselves, the liberalization process must be concerned with the study of technology.

One of the tragedies of our time is the belated recognition of the importance of technical means in the affairs of humankind. Our technical means have been and continue to be a powerful disruptive force in society. Throughout the history of humankind the technical means employed have been our most powerful change agents. The way we live, the way we think about ourselves and others, and our perception of the future are all affected by the form of our technical means. Yet, with very few exceptions, educators maintain they are liberating students and providing appropriate and basic education when the study of technology is ignored. We study sociology, anthropology, biology, psychology, and theology, but not technology.

There has been established throughout history a false dualism that separates ends from means and contemplation from action. This is a very curious position for educators and the institution of education to take. And one wonders why this is so. Certainly we are all aware of the massive changes in our technical means. We are also aware of changes in our society. Many of us are aware that there is a relationship between social change and changes in tools, techniques, and technical systems. Many of us can cite specific instances of new devices and new ways of doing things that are the result of a new invention or innovation. We know today that our choices and potential are totally different from those of our mothers and fathers. A brief review of recent literature in the field of technology identifies terms and phrases that describe the new technical means with their implied and potential impacts

on the future. Terms and phrases* mentioned frequently include numerical control, interactive graphics, fluidics, wind power, space shuttles, geothermal energy, video discs, solar cells, negative feedback, microwave ovens, and dial-a-ride, among others.

And what have our educators been doing at the time some of the most significant human, social, and technical changes in the history of civilization were occurring; at a time when the collective actions of millions of people were legislating a potentially self-destructive future? They were focusing on the goal that education should pay off. And how should education pay off? The answer was: "In a job, in a career, in economic advancement." Are these not the most important

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*Other terms and phrases include: oceanic thermocline, collision avoidance systems, transponders, participatory technology, biomedicine, alternative communities, intermediate technology, coal gasification, breeder reactors, laser fusion reactor, L.E.D.s (light emitting diodes), microwave communication channels, magnetohydrodynamics (MHO), Technology Assessment, fuel cells, linear induction motors, garnet lasers, containerization, technological forecasting, controlled environment greenhouses, ATC (air traffic control), long range satellite earth terrain cameras, Stirling powered external combustion engines, tidal power, hydrogen fuel, fuel injection, electronic ignition, climate stabilization, project Sanguine, ERTS, data networks, land use policy, computer-managed parts manufacture, SI metrics, Opaque-2 (corn), CPUs, LSIs (large scale integrated circuits), FET (field effect transistor), MOS (metal oxide semiconductor), supercritical wing, methanol, ozone, vinyl-chloride, technology utilization, technology transfer, genetic intervention, microcomputer, RAM (random access memory), ROM (read only memory), DABS (Discrete Address Beacon System), CVCC (Compound Vortex Controlled Combustion), cable television, video tape cassettes, video magazines, industrialized housing, VTOL, STOL, V/STOL, biodegradation, and holography, among others.

goals for public education? Many believe they are. However, these goals may be the prelude to social disaster. They may detract from the main mission of education in a democratic society. In fact, the present focus on careerizing and vocationalizing education and the acquiescence of educators to the philosophy underlying these two movements may be establishing the stage for vast political changes only now partially evident.

Today, in a society supposedly based on the premises of democracy and individual freedom and responsibility, the institution of education is concerned less and less with the process of education as a liberating force and more and more with education as a shaping and molding process. The focus has shifted from education and emancipation, to training and enslavement. The goal is to mold individuals to fit the system, a system based on economic rewards and a production-consumption mentality.

As a result, our future and the future of our children is being decided without reflection on, or contemplation about, factors which are more important than the short term issues of jobs, careers, and dollar return.

Each of these developments has already impacted either directly or indirectly on the question of education and what it means to be educated. Educators have believed that to be educated, students should study the literature and values of

the past while those outside the field of education were creating new tools, new technics, and new technical systems which were altering the future. Because of this, the real impact of technology on education may be why questions are being raised about the raison d'etre of the entire educational effort. Why? Because the educational system has for too long ignored the study of one of humankind's most creative endeavors. As a result, we are discovering the impact of the secondary and tertiary effects of technology. We are discovering that the spaceship earth is a delicately balanced entity of finite proportions. We are discovering that continued development of technology has brought about subtle, cumulative, and pervasive changes in both our natural and social environments. And it is these changes which are forcing the reconsideration of the mission of education at all levels. At issue are not the short range considerations of job or career education, but the far more serious and critical issues related to the stewardship of society and the environment of spaceship earth.

By the mid-twentieth century there emerged worldwide a general concern that humanity was facing a crisis of unparalleled magnitude and complexity brought about by a non-directed, ad hoc form of technological development. The naive faith held by many in the complete efficacy of our technical means was shaken. Too many inhospitable environments had been created. Concern for security in the future and the preservation of society set the stage for the realization that the present was not contemplated

or planned but entered into on faith--faith that more was better and bigger was better and that the megamachine was the way to the good life for all people. This blind faith in the megamachine evidenced an impoverished social ethic and an ignorance of the role of technology in social purpose. This mode of social thinking meant that actions by people were reactions against the abuses rather than actions for a new pattern of thinking and vision of the future.

The great issues that are confronting humankind are complex, interrelated, long term, and global in scope. Yet, in an age when more is demanded of everyone and when human beings are supposedly more intelligent and know more, there are indications of increased ignorance; that people actually know less about themselves and the world around them. Langdon Winner, in his work Autonomous Technology, suggests that if ignorance is measured by the amount of available knowledge that an individual or collective "knower" does not comprehend, then the relative ignorance of the population is growing (p. 283). If one assesses the level of comprehension of recent graduates or citizens in general about five major trends of global concern that have come about in the last thirty years some understanding of the seriousness of the issue becomes apparent. These five trends include:

1. accelerating industrialization
2. rapid population growth
3. widespread malnutrition
4. depletion of non-renewable natural resources
5. deteriorating environment (Meadows, Limits of Growth).

These trends, all interrelated, have created a new and different kind of awareness about technical means and social purpose. The new awareness comes about because of the magnitude of the impact of changes in society and, secondly, because of a number of predictions of the irreversibility of the trends (Watt, p. 56).

This new awareness has brought with it the realization that doing more of what we have already done, only more so, will not enhance our humaneness or enable us to live a better life in the future. The last several decades have been filled with action, most of it based on minimal understanding of our complex technological and social systems, much to the detriment of humanity.

Our present systems are operated largely from ignorance. We know little about the past with respect to technology and technological systems and their impact on society, and we know and apparently care little about the future, inevitable as it is. Mostly we operate day-to-day in the eternal present, hoping that someone is concerned about our future. We operate on the faith that someone is steering the spaceship earth.

Yet, there is a new awareness, an awareness that all is not right with our world.

We have become aware that our recent past has been focused primarily on an ever increasing material standard of living, a standard of living based on a capital intensive and energy intensive technical means. We are beginning to wonder if we have developed a technology which has, within the system, built-in self-destruct elements. Many believe, if present trends of increasing production, consumption, and population continue, along with environmental degradation, self-destruction is assured.

Two variables have been identified as factors in the self-destruct equation. They are:

1. Growth. This includes (a) an ever accelerating industrialization and (b) an exponentially expanding world population,

and

2. Energy Utilization. With an ever accelerating industrialization there has been a proportional increase in energy use. The level of sophistication of our present technical means is related directly to energy consumption. The higher the level of technological development in a given society, the higher the energy consumption per capita.

These two factors, coupled with other factors, such as individual resource ownership and a growth mentality, have

set the stage for crises of major proportions, given the present direction of technological innovation. And there is little indication of a change in direction. As Wendell Berry notes, there seems to be a flawed consciousness in our society, which everywhere eagerly connives in the destruction of what it says, and thinks, it wants to preserve (Berry, p. 75).

Population growth, coupled with a higher standard of material living, brings about higher levels of environmental pollution, an accelerating depletion of natural resources, and, eventually, malnutrition resulting from decreasing food supplies. And shortages of resources and food fuel an ever increasing and continuing inflation.

The issues can be placed in sharper focus with some data and examples.

Growth

Until recently, economic growth was accepted as a positive value. The mentality was that more was better. However, an expanding population, utilizing an ever more powerful technical means, exposed the danger of this mentality to society. The critical variable was and is the expansive power of technology. And the critical question today is whether an expanding population (4.3 billion in 1980 compared to a 1.0 billion population in 1798), coupled with an

acceleration of industrialism throughout the world, can be sustained. The prediction is that there are limits; that the population (projected to reach 8.5 to 13.5 billion by 2050) will eventually outrun the potential and projected food supply and industrialization will be limited due to the limits of natural resources and energy.

There are, of course, those who posit that demographic transition will alter the equation and limit the growth of population. Demographic transition is the theory that birth rates decline as the material standard of people is raised. The theory is based on the experience of Western nations. The general pattern is as follows:

> Before development begins, the population is stable at a low level because both birth and death rates are high. In the developing period, the death rate falls dramatically, chiefly because of the impact of medical and public health measures, but the birth rate stays high. The result is a rapid growth in population. In the developed stage the birth rate falls to a point where it is again in balance with the death rate and the population is stable at a high level (Gould, #3, p. 6).

This theory of course raises questions. For instance, how high does the population go during the intermediate stage? Does the population reach a level capable of being sustained, in terms of food, energy, resources, and a standard of living comparable to the Western world today? The danger may be that a given population level, coupled with a given level of technology, will reach a critical mass.

Increases in population, together with higher rates of production and consumption, are accompanied, or have been, by massive accumulations of sewerage, often saturated with toxic wastes, non-biodegradable garbage, discarded consumer products --cars, refrigerators, household appliances, clothing and building materials--stack gases, heat and radioactive wastes from chemical, nuclear, metal processing and electrical production facilities. These acts have placed human beings in a position of interfering, on a large scale, with the ecological balance of the earth, a balance on which all life is dependent for survival. When a certain level of both population and technology is reached, deterioration of the quality of life sets in if economic growth is continued. Inflation increases. Costs per item soar. The ultimate limit, however, may not be numbers of people, or the availability of food supplies or resources. The ultimate limit to industrial activity may be determined by the amount of heat the ecosphere can absorb (Wade, p. 598). It is predicted that serious climatic problems will be encountered in the future with continued development of energy intensive industrialism. Robert Heilbroner notes that if the rate of increase in energy use continues at 4 percent per year, the atmosphere will begin to warm up appreciably, by some 3 degrees in 150 years, setting off all sorts of environmental catastrophies. If this trend occurs, the real need, then, will be to limit industrial growth based on heat energy before critical mass is reached.

Energy

The United States consumes more energy on both an absolute and per capita basis than any other country. In 1971, the total energy produced in the United States was on the order of 57,000 trillion BTUs. It is projected to rise to 92,000 trillion BTUs by 1985 (Commoner, p. 22). To meet these needs will require huge investments because energy production is capital intensive. This means that large sums of money are required to create energy production systems. The pilot SCR II coal liquifaction plant in Morgantown, West Virginia has been estimated to cost 1.4 billion in 1980 dollars. Projections are the cost will increase another 50 to 100 percent before completion. If present trends in energy utilization continue, together with present inefficient energy conversion and utilization processes, then it is predicted that energy production will consume increasing amounts of capital available for investment in new enterprises, including factories, homes, schools, hospitals, other public services and alternative forms of renewable energy (Commoner, p. 27).

The energy equation is central to the question of the quality of life in the near and distant future. If the energy problem is not solved, all else fails; for our present technical system as designed is energy intensive. And the production, conversion, and use of energy are at the base of the problems

of growth associated with a deteriorating environment and the depletion of non-renewable resources.

The critical variable in the energy equation is the exponential growth in the use of non-renewable forms of energy such as oil, natural gas and coal. If the growth mentality is predominant, and it has been, then it can be predicted that a given growth rate per year will deplete known reserves in a specified number of years. This form of growth is known as exponential and operates as follows: 2, 4, 8, 16, 32, 64, 128, etc.

To illustrate the impact of exponential growth on non-renewable resources consider the following. If the amount of energy consumed increases at a rate of 5% per year, then in 14 years the amount of energy used per year will have doubled. This is known as the doubling time. In 28 years the amount of energy consumed per year will quadruple; in three doubling periods the increase will be eightfold. The folly of promoting high growth rates in a finite environment is evident. Yet, most citizens, businessmen, and industrialists are proponents of a 5 to 6% growth rate per year, believing this is the only way to assure a viable society. Consider, however, what happens to population growth in a finite environment and whether we may have reached the point of no return. The illustration is from Albert A. Bartlett (American Journal of Physics, Vol. 46, No. 9, September 1978).

Bacteria grow by division so that one bacterium becomes 2, 2 become 4 and 4 become 8, etc. If we place one bacterium that has a doubling time of 1 minute in a bottle at 11:00 a.m. and observe that the bottle is full at 12:00 noon, when was the bottle half full? More importantly, if you were living in a finite environment and the coal, oil, land, air quality and water were being used up or despoiled at the same exponential rate when would you first realize there was a problem? Would it be five minutes before all resources and space were occupied, 11:55 a.m., when only 1/32 of the resources and space had been used? Or would it be at 2 minutes before noon when only 1/4 of the resources and space had been used? What time is it as far as our own global society is concerned? Doubling time for the bottle, a finite environment like the spaceship earth, illustrates the significance of the problem of growth rates and limited environment and resources. We would probably not even be aware of the problem at 11:59, one minute before noon, because the space occupied by our population would only be occupying one half of the total. Yet, in one doubling time, one minute all space would be filled. There would be no more.

Table I

Time and Finite Space

TIME	SPACE	SPACE
11:54	1/64 full (1.5%)	63/64 empty
11:55	1/32 full (3%)	31/32 empty
11:56	1/16 full (6%)	15/16 empty
11:57	1/8 full (12%)	7/8 empty
11:58	1/4 full (25%)	3/4 empty
11:59	1/2 full (50%)	1/2 empty
12 noon	full (100%)	empty

Albert A. Bartlett, p. 877

Therefore, the critical variable in the discussion of energy or any other non-renewable resource is not how many tons, barrels, acres or BTUs remain, but the growth and use rate.

Some rather obvious answers to the energy issue become apparent. (1) Reduce the consumption of energy through better management, use patterns and altered life styles. (2) Redesign our technology--search for technical means that are less energy intensive and more efficient. (3) Search for new and alternative forms of energy that are renewable, non-polluting and less capital intensive.

The latter can be accomplished by turning to income fuels including solar, wind, water, and geothermal. Currently, these sources of energy contribute less than 4 percent to

the total production of energy. Predictions are that in the future these sources and others will have to contribute 70 to 90 percent of our energy needs (Cornish, p. 277). In the United States in 1978 gas and oil, both finite resources, provided 74 percent of the energy consumed. Coal, geothermal, hydroelectric, solar and other forms of energy provided the rest. In 1979 over 45 percent of the oil consumed (8.2 million barrels per day) was imported.

The prognosis for change, based on the behavior of people and government, is not favorable, however. In 1974, for instance, the Energy Research and Development Agency (ERDA) selected nuclear weapons production and development as the highest priority in its budget. The next largest budgeted item was for the civilian nuclear program, including the breeder reactor. Coal research and development were targeted for only about 10 percent; conservation of energy programs, 3 percent; and income energy sources, such as geothermal and solar, about 1 percent (Abelson, Science, July 28, 1974). This was truly an incredulous stance for ERDA and Congress to take at that time, given the seriousness of the energy problem. The Department of Energy in 1979 still assigned low budget priorities to renewable energy options.

Other Problems

Other problems associated with a capital and energy intensive technology are threats of climate modification

resulting from increased levels of CO_2 in the atmosphere from the increased use of fossil fuels. Also, serious environmental problems have resulted from agricultural mismanagement, uncontrolled population, deforestation, overgrazing, desertification, soil erosion, and flooding. It is interesting to note, however, that in many places in the world the destruction of the land has not been because of high technology misused, but rather the practice of techniques inappropriate to the environment by people living in nomadic and tribal societies. Many of these people are ignorant of ecology and ecological systems. The fact one lives on the land and takes nourishment from the land is no guarantee one is knowledgeable of the many variables associated with fragile ecosystems. Worldwide, there are numerous examples of people ignorant of their life support systems who use inappropriate and destructive technical means. In the process they plant the seeds for their own self-destruction. Recent examples are deforestation in Nepal, desertification in the Sahel and the disposal of chemical wastes by the Hooker Chemical Company in the Love Canal area of Buffalo, New York.

In the United States there are over 1100 carcinogens to which workers in various industries are exposed each year. Some 600 new chemicals are introduced each year, some with known and many with unknown side effects for the workers who produce them and the consumers who use them. The problem of

toxic substances is worldwide. China has reported that 15 of its 27 main rivers are seriously polluted and that the tap water in 41 of 44 cities tested did not meet minumum health standards.

There are water crises throughout the world as there are energy and resource crises. The next serious crisis in the United States will be water. Many are predicting major shifts in industry and population because of the depletion and pollution of water supplies. In Arizona, for instance, a swelling population, continued agricultural expansion and increasing industrialization have been depleting the ground water supply. It is a problem that has been known for over 50 years. It is now a crisis and Governor Bruce Babbitt believes it is the most important issue facing the state (Mark Stevens, Christian Science Monitor, February 12/80, page 6). Similar problems plague Colorado and western Nebraska. Virtually all of Colorado's surface water is contained in four watersheds of modest size, the Colorado River, the Rio Grande, the Arkansas, and the Platte. The water from all but the Colorado is 100 percent allocated. The ground water is being withdrawn much faster than it is being replaced. A 2000 acre irrigated farm in the western U. S. uses as much water as a city of 50,000 people.

Not only is use of water a problem but contamination of the water supply is a serious problem for people and

aquatic life. New Orleans has a cancer mortality rate 32 percent higher than the national average. There have been 112 organic chemicals including known carcinogens found in the drinking water. The most harmful chemicals that get into the food chain are chlorinated hydrocarbons and brominated hydrocarbon. The most dangerous are the polychlorinated biphenyls (PCBs) used to manufacture plastics, lubricants and paints. There is concern fish that ingest PCBs will stop reproducing and that people who eat contaminated fish will increase their chance of cancer.

Land use has become a serious issue mainly because so much good farm land is being taken out of production and used for housing, business and industrial development. Land is treated as a commodity to be bought and sold to the highest bidder rather than as a resource for food production. Fertile farm land around major metropolitan areas is the most vulnerable. Many farmers are forced to sell because of spiraling property taxes. In the northern part of Virginia where the soil is ideal for farming an estimated 1500 to 2000 acres of farmland are taken out of production each year to make way for urbanization. In the U. S. over 100,000 acres per year are taken over for urban development. Small farms are particularly vulnerable. In 1935 there were 6.81 million farms in the U. S. In 1979 there were only 2.37 million and it is predicted that this will decline to 2.31 million in 1980.

The belief that fewer acres can produce more and more food through the use of chemical fertilizers, irrigation, genetics, intensive cultivation and more mechanization is now open to question. There are limits to the dramatic increases in production occurring since the mid-1930s. We seem to be reaching a natural yield ceiling which will impose a limit on future productivity growth.

Most lay people believe that someone will find a way out of these problems; that someone will discover new and magic machines or processes.

The question is, "Will there be time?"--time to develop the new technologies; time to create new social mechanisms for social control. What is at issue is lead time. The creation of new and alternative technologies, as well as new and alternative social mechanisms, requires more and more time the more limited the resources and the more sophisticated the technical means become.

The critical variable at this juncture seems to be social control. Our command over natural processes and forces far exceeds our techniques for social control, including planning and decision making. This is a relatively recent realization.

There seems to be an awakening to the need for social action. Recent research indicates a slackening of public approval for new technologies. There is more questioning.

Technological progress is no longer accepted as good. There is a growing distrust in the way power holders manipulate the world; concern over maldistribution of resources; anxiety about the ethical implications of further technological advances in some areas of medicine and the biological sciences; and growing awareness that much scientific research lacks social relevance (LaPorte, p. 121).

The public is becoming more and more aware of problems associated with the use and application of technology. Included is the growing realization that:

1. Work in a high technological society can kill. (HEW estimates that 100,000 U. S. workers die each year from occupational diseases.)
2. Inappropriately applied technology can destroy people and environments. Witness the inappropriately applied deep well technology in the Sahel. There was no social control and the nomads, carried away by the promise of unlimited water, forgot about the Sahel's limited forage. Centuries-old tribal agreements which apportioned just so many cattle to graze just so long in certain locales were ignored. Herds were increased, overgrazing resulted, and each well became the center of a desert of its own (Atlantic Monthly, May 1974).
3. The social costs of the automobile are becoming excessive whether one considers the pollution

factor, the energy problem, or the fact that 200,000 people were killed in automobiles in 1972, creating great losses and increasing capital investments in the form of hospitals and rehabilitation centers, among others.

4. The products of technology, designed from an economic rather than from a human or social point of view, have built-in hidden social costs. Witness the planned obsolescence of the American automobile and the new American ghettos created by the "Mobile Home Revolution."

Searching for Answers

For years, unplanned technological growth and development have been accepted as inevitable. Invention and new development have been dependent largely on individuals, private entrepreneurship, and so-called luck. But this may change. Some people have discovered that technology can be influenced by human beings. And some people have gradually begun to realize that the principal limitations to developing new or alternative forms of technology are not technological constraints, but rather, our own human conceptualization of the way things can and should be.

We may be on the verge of a spiritual awakening with a new vision of human and social destiny and being.

Analysis of the past 200 years, during the period of industrialization of the Western world, indicates a certain spiritual emptiness with regard to humankind asserting control over the future. This point of view results when a few make choices for the many, a fact with considerable importance with respect to technology. Holloman (p. 10) notes that the technical means employed in a given society depend markedly on that society's particular cultural and political framework; on its resources, values, and myths. This fact has been known for some time by those who have studied social and technological systems. Leslie White, in his work, The Science of Culture, 1949, discussed the same point and showed the interrelationship of society and technology.

> Every social system rests upon and is determined by a technological system but every technological system functions within a social system and is therefore conditioned by it (p. 382).

This being true, the central problem of our time and the issue which should have a great impact on our concept of what it means to be educated is the search for alternative technologies which meet the needs of human beings and enhance the quality of life in all its dimensions.

Technologies designed to enhance the quality of human life do not begin with new devices. These technologies begin with people and their education, organization, and discipline.

It is for this reason that educational programs should be dedicated to the study of technology, humankind's survival kit, together with the education of the human mind and spirit for the purpose of creating on this earth the most humane existence ever. The options are ours. And it is the human mind that will make the difference. Our challenge is to exercise our humaness. And we are human, according to Rene' Dubos,

> to the extent that we are able and willing to make choices that enable us to transcend genetic and environmental determinism, and thus to participate in the continuous process of self-creation which seems to be the task and the reward of humankind (p. 80).

Two factors stand out in Dubos' description of being human. One concerns ability; the other, willingness to make choices. The first is of the mind. The second is of the spirit. Both are necessary components of the educated person of the future.

What does all this mean? Essentially, it means humankind has a choice. Doomsday is not inevitable. It is possible, even probable, but not inevitable. The golden age for humankind can come about, but only if we make radical changes in our behavior as stewards of the spaceship earth.

Who are we? Why are we here? Where are we going? How are we going to get there? These are the great questions that

still call out to be answered. These are the questions the answers to which will provide us with direction for the future, an operating base, a philosophy. Trite? Perhaps so. But one only need recall the immediate and not too distant past to observe the results of a concern for power without a philosophy. On October 1, 1972, the New York Times published an editorial which points up the issue of philosophy, goals, and leadership. The lead paragraph sets the stage.

The Leadership Issue

> The overriding consideration in this Presidential campaign is what may be called the leadership issue. As we noted Thursday in our editorial endorsement of Senator George McGovern for the Presidency, The Times believes that President Nixon has failed to lead the American people with any sense of moral purpose toward the broad social, economic and political goals of this American democracy. Despite some major accomplishments, this Administration has appeared to govern during most of the past four years not with any evidence of inner conviction and outward vision but rather with a mixture of opportunism, insensitivity and confusion of aim.

If we are to operate with clear vision, we must search for the proper goals for humankind, goals that are progressive and promote human values. We must search also for the means to attain these values once determined. In addition, we must find the means to control and manage the process once determined. Each of these steps will involve new and alternative forms of technical means. The difference will be that we will have made a choice, a choice to direct and control technical means to promote human values.

Again, there are implications for education. A society's capacity to make choices, to decide goals, and to produce desired changes is directly influenced by the general level of education of its citizens, particularly in basic knowledge about self, others, community, technology, the environment and the future.

A Social Transformation

The problems and issues facing people throughout the world today seem to require a social transformation of significant magnitude. The continuation of the present with its decreased sense of community, alienation, purposelessness, and problems associated with resource depletion, inflation, increasing complexity, unemployment, malnutrition, and environmental degradation portend disaster. A competitor to the industrial model which gave rise to our present untenable problems seems to be evolving. Behind the transfiguration in values has been the growing realization that vision of the future based on the industrial model has serious flaws. Those who are concerned about the future question the position of those who call for more of the same. They wonder if many of the problems of the world are not the result of the design of the technical system and its supporting social system. The question has become one of entertaining the possibility of whether there are not <u>alternative forms</u> of technical means that would be more appropriate to human beings and the living environment.

The new vision contains new means for measuring the performance of social and technological systems. Rather than depending on the Gross National Product (GNP) as an indicator of the nation's wellbeing, social indicators that measure the quality of housing, public safety, education, work and employment, income, leisure and recreation, physical health and psychological wellbeing, and cultural experiences have been created. Other factors which have to do with the physical quality of life and which are used to assess social and technological choices include life expectancy, infant mortality and literacy. The fact a country has a high GNP, such as the United States, does not assure citizens a high quality of life. In fact, the U. S. ranks below many countries in a number of categories.

The generally accepted measure used to determine how well we are doing is the Standard of Living Index which is based on the theory that living improves as the per capita share of material goods increases, either by increasing production or by decreasing losses or a combination of both. The formula is

$$SL = \frac{\Sigma \text{ production} - \Sigma \text{ losses}}{\text{population}}$$

Wagar suggests that this measurement is too limited; that what should be assessed is the quality of life. He created a Quality of Life Index for use in making decisions for the control of social and technological systems. The Quality of

Life Index places a value not only on material goods but also a value on the quality and quantity of both services and experiences available to each person. Thus, the environment becomes a factor in decision making. If the environment deteriorates, fewer opportunities are available for quality experiences or services are reduced. The formula is

$$QL = \frac{\Sigma \text{ Production} = \Sigma \text{ Losses}}{\text{Population}} + \frac{\Sigma \text{ Services/Time}}{\text{Population}} + \frac{\Sigma \text{ Experiences/Time}}{\text{Population}}$$

A New Ethic

The social transformation that is taking place is based on a new ethic founded on an altered consciousness and a new logic. Whereas the industrial model promotes standardization, centralization, competition, material satisfaction, efficiency and thinking in categories, the logic of the new ethic focuses on destandardization, local control, symbiosis, interaction, cultural satisfaction, esthetics and thinking in social context (Maruyama, p. 43). The new ethic that is emerging is part of a shift that occurred during the 1960s and 1970s when an increased emphasis on the humanistic, the spiritual, the quality of life and community, and a concomitant decreased emphasis on materialistic values, status goals and undifferentiated economic growth occurred (Harman, pp. 107-108).

Implied was a new and altered consciousness on the part of world citizens. To live in a destandardized, heterogenetic, symbiotic, interactive society would require citizens that

could and would acquire knowledge about technological and social systems and would accept responsibility for the management of these systems. Systems that have as the criteria of success interaction, living in harmony with nature, cultural satisfaction, and thinking in social contexts are totally different from those that promote standardization, homogeneity, competition, hierarchy, mastery over nature, material satisfaction, efficiency and thinking in categories.

Other value shifts which emerged in the Western world have been identified by Carl H. Madden of American University. Shifts were from quantity to quality, from merely "more" to "better," from independence of nations to interdependence, from exploitation of nature to living in harmony with nature, from priority of technical efficiency to technical efficiency with ecological justice, from authoritarian governance to participative governance, from work as sacrifice to work as purposive and self-fulfilling, from centralism and uniformity to pluralism and diversity, from dominant concern for material needs to growing concern for social wants, from preoccupation with things to a desire for experience (Newsfront, p. 26).

The new ethic that has evolved consists of at least four key components or sub-ethics.

- The humanistic ethic. This ethic directs individual and group actions toward the enhancement of human development and personal growth, not the technical enterprise.

- The ecological ethic. This ethic recognizes the critical relationships between the quality of human life and the natural environment.
- The global ethic. This ethic directs attention to the understanding of human beings, social systems, technical systems, ecological systems and the environment as all part of one interrelated symbiotic system.
- The enabling ethic. This ethic is founded on the emergence of the realization that technological systems can be designed and controlled for human purposes and that the design and development of appropriate technical means will enable human beings to create a more humane future.

The new ethic emerged from new information and knowledge and a new awareness by more and more people of how complex and interrelated the natural world really is. It came about also from the realization that the earth was not large enough and the resources plentiful enough to tolerate in any long term future the escalation of the current egocentric and aggressive technical behavior on the part of its inhabitants. The focus of the new ethic is on the need for new global patterns of cooperation and interdependence with new relationships among people and between human beings and the natural environment. The new forms of symbiosis which are contemplated are based on the premise that the survival of life on the planet at any level of existence beyond mere subsistence will require the redirection and redesign of the technical means. In addition, any truly human future requires the correction of the growing imbalance in the world between the rich and the poor, between the developed and the developing nations. The latter Maurice

Guernier believes to be the sine quo non of any world order (Guernier, p. 1, Development Forum, November-December 1977). Without this new balance among people we will have nothing.

Appropriate Technology

The new ethic implies a new form of society. However, irrespective of the form of the new society, there can be no new society without appropriate technical means. No society at any level of sophistication exists without some form of technical system. Transformation to a new form of social order requires that critical attention be given to technical means, the enabling element in any social system. Only the means appropriate to and compatible with the social design will enable the transformation to occur.

The appropriate technology movement originated from this new awareness and from two different areas of the world. The first emerged from the realization by developing countries that the type of technical means being introduced by Western or developed countries had not fulfilled original promises and expectations. In many cases the solutions were detrimental, destructive and regressive. The technical means introduced were found to be inappropriate to the culture, to the skills and knowledge of the people, to the needs of the people, to the local and regional environment and the perception of the people about the role of technology in the scheme of things.

The affluent Western world was the setting for the second origin of the appropriate technology movement. The 1960s were a decade of marches, debates and the questioning of national purpose. It was during this period of time that the crises some had been predicting became highly visible. Among the more significant were the development of an increasingly severe energy shortage with few adequate solutions; a world food problem affected directly by energy shortages, land use policies, population increases and the continual loss of arable land through urbanization and destructive agricultural and resource management practices; the increasing deterioration of the earth's biological systems; and the realization that life on earth depends and will continue to depend primarily on renewable resources.

The goal of the appropriate technology movement is to create a more livable future, a future based on technologies more compatible with human beings and the natural environment. Proponents of appropriate technology would vote against Nigel Calder's candidate whose election year platform offered a richer and more hectic world, a world where people would be surrounded by more things, with more noise, accidents, injury, mental illness, and stress related diseases; a world where armies would be fielded to capture the resources of the world; where the goal would be the creation of a wholly man-made world and where all wild animals would be banished to museums, yet where with potent protheses it would be difficult to tell

man from machine; a world where ad hoc entrepreneurship would be encouraged to produce unneeded inventions to confuse the public and where inventions such as the computer would be used to create a national information network to watch the action of every citizen and strengthen the power and brotherly eye of central government. Such a platform would, in all probability, be rejected by most people. But the potential reality is all too true and serves as a reinforcement for those who opt not for a free technology and a controlled citizenry, but for a controlled technology and a free citizenry. The goal of appropriate technology is a participatory technology in a participatory society.

The concept of appropriate technology challenges the existing order of society, particularly the values associated with narrow rational thinking, hierarchical orders, and centralized government, institutions and industries. The thrust of appropriate technology is toward diversified and prosperous societies developed around local and regional skills, environment and resources by self-reliant, well educated people. The goal is to use technology for human and social purposes. To accomplish the goal will require the redesign of present technical systems.

Redesigning Technical Systems

Any future society will require some form of tools, machines, materials, techniques and technical systems. A truly humane future would be impossible without some form of technological base. Any future must provide for some means to provide food, clothing, shelter, health care, transportation, communication, education, and employment, as a minimum for survival.

It is also obvious that societies with limited technical systems provide limited potential for human development. Societies with inappropriate technical systems not only limit the potential for human development but also are destructive of human beings and their environment.

When the technical base is inadequate or inappropriate people are restricted, confined, and limited. Oftentimes they become slaves to an inadequate and inappropriate system. Just the opposite is true when technical systems are well designed and efficient and integrated with the basic needs of human beings and compatible with the environment. When this is true human life is enhanced.

How these needs are met is a question of social purpose and technical means. Any commitment or transformation to a new social form will require that the technical means be appropriate to the new ethic. This will require, in many

cases, the creation of new means. But what means? The selection of appropriate means presupposes a knowledge of technological systems and their design, as well as an understanding of human beings and their needs and desires, and the relationship of these to the structure, organization and function of social systems.

In addition, the creation of new means is a question of starting from where we are. Obviously, technical systems already exist which occupy physical and social space and utilize resources. Most people are not prepared mentally to perceive the world differently. They accept things as they are and are unable or unwilling to consider that alternatives exist or could be created. Generally the response is: "It has always been that way." "How could it be any other way?" "There is only one way." or "Whatever can be will be." This no longer need hold true. The adoption of new technical means and the course of technological development can be controlled. Witness the supersonic transport program, project Sanguine, and certain highway and marine terminal proposals. The new awareness that accompanied these citizen participation efforts extended beyond the discovery that ad hoc entreprenural means could be controlled, to the realization that new and appropriate technical means could be created. The limitations of human conceptualizations about human beings, the earth and the future were being breeched

and alternative futures more likely to enhance the quality of life and the long term dynamic stability of the biosphere contemplated. This change in consciousness brought about the realization that human beings could create and apply knowledge about people, technical and social systems and the biosphere to design compatible and adaptive systems which would supplement, enhance and facilitate human goals.

The possibility of redesigning technical systems to serve human and social purposes is of relatively recent origin. No established method of inquiry or body of knowledge exists which provides a commonly agreed upon procedure for doing things differently. Using the criteria of the industrial era will only add to the potential crisis. Criteria compatible to the new ethic must be established for the selection and evaluation of the new means.

Design Criteria

The primary criteria in the equation and the one which will greatly simplify the issue and lessen the concern about the necessity of all citizens becoming masters of all the intricacies of all technical means is the <u>human element</u>. Rather than making decisions about whether a given technical device is more efficient than another technical device, decisions would be made as to whether a given device improved the quality of life of individuals and increased the probability

of their reaching their full potential as human beings. Related to this primary element are criteria related to the degree to which the alternative means serves predetermined social purposes and contributes to the long term dynamic stability of the ecosphere. These three criteria--the human, the social, and the environmental--will direct the focus toward the human center and aid in determining when proposed technical means threaten or limit human and social purposes and when they do not. Perhaps more importantly it will be necessary to be sensitive to those instances when failure is the failure of human ethics and not technical means; when the creation of dehumanizing conditions is the manner in which the tools, machines, techniques, and technical systems are integrated into society.

In addition to the general criteria already mentioned there are those related to the goal of appropriate technology which is to assist people to transition to a self-reliant and more meaningful form of existence. Criteria related to this goal include the creation of human scale technologies and ways of thinking which will promote the wise use of resources, more harmonious connections with the natural world and small, more workable, less complex governmental and social institutions. These criteria are based on values which promote, among other attributes, material sufficiency coupled with psycho-spiritual growth rather than material

growth; enlightened self-interest rather than competitive self-interest; cooperative individualism rather than rugged individualism; rational and intuitive behavior rather than rational only; and design with and living with nature rather than dominance over nature (Elgin and Mitchell, Futurist, August 1977, p. 202). Other criteria can be derived from objectives which stress the creation of less complex living and working environments, reduction of material complexity or ephemeralization, greater local self-determination, more integrated work roles and cultural diversity. Each of these goals and objectives imply characteristics which can serve as criteria for the design of technical means compatible with the new ethic. Other more specific criteria require that the technical means be ecologically sound, and based on high energy efficiency and use of renewable energy sources. Emphasis is placed on product designs that incorporate long term use, can be manufactured using local material and labor and are made from reuseable materials.

A number of the criteria are related to social elements such as the stress on a low level of specialization, with operating modes understood by all, democratic and participatory politics rather than consensus politics, innovation regulated by social needs and the integration of all members of society into the community where work is undertaken for personal satisfaction and the goal is self-reliant neighborhoods and communities.

The question is often raised as to whether so-called high technology is appropriate technology or not. There are numerous examples of technical means that have been created which enhance the quality of human life. Whether these are appropriate technologies or not depends on the interpretation of the criteria. For example, thermography is used to detect breast tumors. A thermograph is a heat picture which detects the extra heat generated by a growth in contrast to the surrounding tissue.

Another example is Opaque-2, a new corn with nearly double the effective protein content of normal corn, nearly as much as meat, and greater than milk. If the Opaque-2 gene can be transferred to the world's corn crop, it will be like adding ten million tons of protein to the world supply each year. This one development could eliminate the typical malnutrition which exists in societies whose basic protein supply comes from corn (Friggens, p. 144).

Technology also contributes to new knowledge about our environment. Many of these developments came from the space exploration effort.

Earth orbiting satellites are one example of a technology that has had and will continue to have tremendous impact on the quality of life on earth. Again, a primary element in solving problems, namely, information, has been made available.

The Earth Resources Technology Satellite (ERTS) and the Nimbus weather satellites are prime examples. ERTS shows great promise for data gathering for such activities as inventorying crops to determine the world food supply, planning efficient land use, prospecting for natural resources (oil, minerals, water), monitoring pollution, and preparing new maps for census taking.

Nimbus satellites have aided immeasurably in weather monitoring and predicting, saving many lives and increasing the probability of better harvests.

There are numerous examples of the redesign of technical means. One example comes from the work of Dr. E. F. Schumacher who created the Intermediate Technology Development Group, Ltd. to assist developing countries in finding or creating the technologies most appropriate to their needs.

One effort was the development and construction of an egg-tray production machine costing $19,500. The machine was scaled to the needs of Zambia which had asked for assistance. The cheapest machine available on the international market cost $390,000 and would produce a million trays per month, far more than Zambia needed. The smaller machine was designed and manufactured locally. It offered more employment opportunities, a lower capital investment and was flexible in design so it could be used to fabricate other items besides egg trays.

Another organization attempting to develop technical means appropriate to local needs and conditions is VITA (Volunteers in Technical Assistance). An example of one phase of their efforts is the evaluation of technical devices in existence. William Ellis, VITA consultant, arranged for the evaluation of the Nadeau Weaving System based on a hand loom costing $600 which is eight times as efficient as other hand looms.

Dr. Ishrat Usmani, senior energy advisor to the United Nations Environment Programme (UNEP) has promoted the testing of the use of solar energy, wind power and fuel production from manure and agricultural wastes (biomass conversion) as a means of providing the energy needs of villages. These technologies are much needed in many developing countries since the supplies of firewood have become perilously low from overuse of the woodlands for fuel. In many villages it requires a full day's journey from home to source of wood and return.

Many solutions have been proposed for the energy problem. Not all are acceptable. One frequently proposed is atomic energy. But there are serious political, social and environmental issues. Dr. Ishrat Usmani who served previously as director of Pakistan's Atomic Energy Commission concluded that alternatives must be found to nuclear power. From his experience fuel-starved developing countries would be ill

advised to introduce nuclear power. Such a course would not only drain their limited trained manpower and scarce capital resources, but would make the countries totally dependent on imported fuel, millions of dollars worth of spare parts and foreign supervisory personnel. The latter creates a psychological dependence on the part of the people on getting more aid. This saps the initiative of people and people are the key to any transformation to a more humane future. Additionally, nuclear energy, compared to solar, requires a specialized elite and is a capital intensive centralized technology controlled by a few, thus posing a threat to the freedom of citizens and the transformation to societies which enhance the participation of citizens in the creation, operation and control of the technical means which affect their lives both physically and psychologically.

There can be no true transformation unless people have an opportunity to work for it and take part in it according to their own needs and perceptions. Any long term sustained change for the betterment of human life must focus on people. People are the solution and human development at all levels is the goal and focus of the appropriate technology movement. The means is through assisting people in gaining new skills and attaining new perspectives so they can see from their own experience that things can be changed and how this can be accomplished.

Considerable research is in progress in the design of alternative technical means appropriate to criteria focusing on human development, satisfaction of basic needs, self-reliance and living in harmony with the environment. Some of the most prevalent efforts have been investigations in bioconversion of fuels from plants and wastes; wind power; solar energy including photovoltaic energy, solar thermal energy conversion, ocean thermal energy conversion; solar heating and cooling; geothermal energy; energy storage including magnetic, mechanical, thermal, compressed air and chemical; water systems; "waste" and water management recycling; bioshelters and shelter design; aquaculture; waste disposal; composting; anaerobic digesters; hydroponics; greenhouses; passive heating and cooling systems; small scale food and fiber production; small scale industries based on local materials and local needs; self-reliant single family dwellings; and retrofitting older urban structures.

The idea of appropriate technology challenges the existing order of things, especially the values of centralized government, centralized institutions and large scale centralized industries. Numerous changes will be required in public policy. Present policies subsidize large-scale standardized activity at the expense of diversified local enterprise. The government subsidizes large-scale water projects for large-scale agri-businesses and highways for the long-distance movement of

products produced by large producers and shipped nationwide. Many building codes contribute to increased specialization, specialized materials and higher costs.

The support by the government of the constant movement toward large centralized capital intensive technology has meant that many efficient small-scale processes have given way to large-scale inefficient systems. In many developing countries large centralized industrial plants were established when the real needs were basic shelter, water systems, health care, food and energy supply. In developed countries similar inappropriate technical systems have been created. For instance, the extensive use of machines in agriculture has resulted in a system which consumes more BTUs in fuel than it produces in food BTUs for consumption. The advanced technology of the 20th century has failed to solve the persistent problems of food supply and shelter. Perhaps other forms of technical means will be more appropriate.

Appropriate Education

The social consciousness and logic of the new ethic forces attention to several very critical elements. To live in a de-standardized, heterogenetic, symbiotic, interactive society will require a new kind of citizen, a citizen with a new world view that encompasses an understanding of people, technical means, social structure and environment in terms

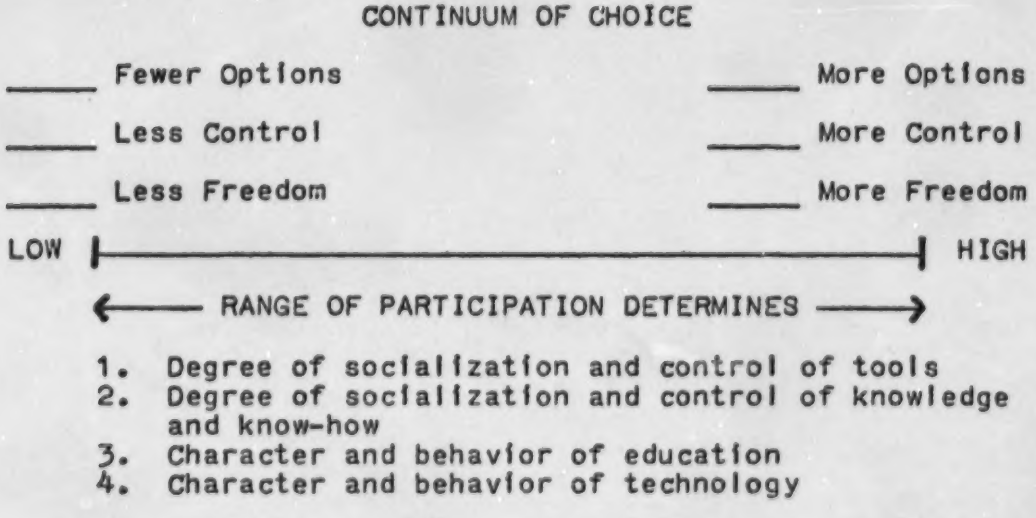
of the symbiotic relations and interactions within the systems. Secondly, the new ethic will charge each citizen with responsibility for participation in the management and control of the systems. This implies a different kind of education, one that incorporates much new content and many new processes. The new ethic requires a better and more fully educated citizen than ever before. This becomes particularly important if the regulation of the social order is to be by democratic procedures where final authority is to the whole, rather than the part. If there is to be participation in the determination of technical means, this implies a participatory democracy where a sense of individual moral responsibility for behavior that affects the whole community is imbedded in the consciousness of each and every citizen.

The concept of participatory technology emerged for several reasons, all of which have to do with the power and control of technical means and concern about the primary, secondary and tertiary consequences of decisions that will affect the long term future. The premise is that the only possible guarantee of a livable human future is responsible behavior in the present. And responsible behavior requires informed, concerned, participating citizens. Those who are not well educated and those who do not participate are detriments to themselves and others. They have fewer options, less control and less freedom. They also, by default, permit

others to choose their future for them. The level of citizen participation is critical to the design of more sustainable and more human environments. The level of participation determines many variables in society including the character and behavior of educational as well as technical systems as is illustrated in the following figure.

Technological Literacy

Traditionally the question of what should be done technologically has been determined primarily by individual inventors and entrepreneurs answering the question of what can be done technologically. This was not a serious problem when the tools, machines, techniques and technical systems were limited in scope and power. They were also limited in their impact. Today the issue is one of closing the gap



between a social naivete regarding the sophistication and appropriateness of technical means. Yet, on examination one finds little effort by those responsible for the education of future citizens to close the gap and prepare citizens capable of deciding and controlling our social and technological systems. The focus of attention was and still is on the preparation of individuals who determine what can be technologically rather than on citizens who are prepared to determine what ought to be technologically. The focus has been on the growth of technology, not the social and political problems resulting from the application of new tools, machines, techniques and technical systems. Nor has the emphasis been on the future and the creation of alternative futures based on designs to fulfill agreed upon social purposes.

The question of what ought to be concerns personal and public decisions and behavior and requires knowledge and understanding about the behavior of technological and social systems and the interrelations between technical means, people, social systems and the natural environment.

Historically, educational programs have focused on the assumption that individuals with a knowledge of the past would be able to adapt to the future. It is doubtful if this was ever true. However, the nature and power of technical means today have created an era with no counterpart in the past.

Total reliance on information from the past to make decisions about the future holds potential for disaster. The present is not like the past and the future will not be like the present.

If we and those that follow us are to behave in a knowledgable and responsible way we must educate ourselves to do so. This will require major changes in our perception of the role, content, structure and process of our educational programs, particularly those that prepare teachers responsible for educating citizens for the future. People will act; they will do something; it is best they do it intelligently.

As a minimum, consideration must be given to the creation of new curricula incorporating the study of humankind; other cultures; social, technical and environmental systems and the behavior of these systems; decision making processes; change processes; the history and development of technology; goals and values in human societies; technological assessment; technological forecasting; the interrelation of systems and the behavior and control of systems, both technical and social; new technologies and technological systems including power and energy systems, transportation systems, communication systems and production systems; alternative technologies; intermediate technologies; future social and technological systems; and the design of new technologies and new social and technical skills, among others.

New curricula for the public schools and colleges and new teacher education pre-service and in-service programs will be necessary. In addition, the design of new instructional strategies based on the most current research on communication processes and instructional systems will be required.

To carry out these tasks a regeneration of the field of education is needed; a massive re-education of all practitioners, if any real contribution by the field of education to the education of youth for a future in a technological society is to take place. What is needed is new knowledge, new levels of awareness, new sensitiveness about humankind, about society, about technology and about the role of education in contributing to the education of individuals toward a more humane future.

This will require, for many, a reorientation of prevailing views of the purpose and function of education. The present emphasis on short term programs concentrating on jobs and careers will, on examination, be found to be destructive of the potential of education in creating a more humane society.

<u>What if</u> during the past thirty years the educational system had actually pursued the study of technology and social purpose, rather than focused attention on diverse efforts such as vocational programs, world of work programs, and antequated college preparatory or pre-vocational programs? <u>What if</u> during these years work had been carried on in the study of

technology and technical systems and the interrelationship of these systems to society and the environment? What if during these years our focus had been on basic education in the technologies and the design and evaluation of technical means for the home, the community, the social system? What if education had focused on the study of work, not from the standpoint of preparing for a job, but from the standpoint of work as a critical variable in psychological wellbeing and a meaningful existence? What if education had focused on the design and redesign of technology to enhance work as a means of enhancing human beings? What if the practitioners in education had focused on the study of technology and the future and the span of civilization, rather than on the past and, to some extent, the contemporary present? Is it possible our citizens would have made other choices about the type and rate of development of technology? Is it possible that alternative forms of technical means would have been developed; that systems of control would have been created that would have provided stability rather than instability?

If we believe in the potential of education as a creator of intelligent capable beings, then we would necessarily answer in the affirmative. Yes, today would have been different had the educational system included as a part of liberal education the study of one of humankind's most creative endeavors, technology.

But it did not. Instead, education and educators faced the future by looking backwards. They based the educational process on the past and conventional wisdom while supposedly preparing citizens for the future.

We are at a turning point in civilization. Much of the technical means used to arrive at the present does not seem to be appropriate for the next century or even the remaining decades of the 20th century.

Even with the extensive research effort taking place throughout the world, primarily by individuals and small groups, there is much to be done if a viable transformation is to take place. Changes must be made. A new commitment to stewardship is required, a stewardship that proclaims that technical means must be subservient to people and that new means can be created, controlled and managed for human purposes.

The quality of human life in the future will be determined by the creative spiritual power latent in every human being, from an understanding of the interrelationships of social, technological and ecological systems and by the wisdom of choices made by each and every person as part of a collective human action.

Is it too late for educators to take a stand and opt for a more stable and humane future? The record of educators as change agents has not been exceptional. Generally, the significant changes in educational institutions, in disciplines, and

in various fields of endeavor have usually been made by people outside the institutions or disciplines or by the young or by those new to the disciplines.

Thus, if we desire to make changes in education and to alter the future of society, we must solicit the assistance of those with a new perspective; those outside the institutions of education, the young, and those new to the disciplines. I propose we seek people such as these who will provide us, through study, reflection, and contemplation, with plans for purposeful action based on knowledge and understanding of the behavior of technological systems with the goal of directing technical means toward the creation of a more humane future for all people. Only in this way can we enter the future by choice and not by chance.

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